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10/593,444	02/05/2007	Makiko Kitazoe	029567-00011	8995

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EXAMINER	
MILLER, JR, JOSEPH ALBERT	

ART UNIT	PAPER NUMBER
1792	

NOTIFICATION DATE	DELIVERY MODE
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No.	Applicant(s)	
	10/593,444	KITAZOE ET AL.	
	Examiner	Art Unit	
	JOSEPH MILLER JR	1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *05 February 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-18* is/are pending in the application.

4a) Of the above claim(s) *1-7* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *8-18* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☒ Claim(s) *1-18* are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *09/19/2006*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

Restriction is required under 35 U.S.C. 121 and 372.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1.

In accordance with 37 CFR 1.499, applicant is required, in reply to this action, to elect a single invention to which the claims must be restricted.

Group I, claim(s) 1-7, drawn to apparatus.

Group II, claim(s) 8-18, drawn to method.

The inventions listed as Groups I and II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the use of a catalyst body for the deposition of a SiN film using hydrogen and silane gases is known in the art (2002/0104477). The use of the catalyst body or the hydrogen plus silane gases to form SiN is considered to be the special technical feature since the application of hydrogen and ammonia plasmas to treat SiN films as well as the deposition of multilayer films is well known in the art.

During a telephone conversation with Mr. George Oram on November 20, 2008 a provisional election was made without traverse to prosecute the invention of method, claims 8-18. Affirmation of this election must be made by applicant in replying to this Office action. Claims 1-7 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Specification

The disclosure is objected to because of the informalities list below.

1. The claims are referred to in the specification [0009-0026]. The specification can not refer to the claims.

2. Paragraph/sentences [0093 and 0094] are unclear is as written. It is unclear exactly what is defined as a rare gas.

3. Paragraph/sentence [0095] is unclear is as written, it is not clear to exactly what "case" the use of steam is referring.

Appropriate correction is required.

Claim Objections

Claim 8 is objected to because of the following informalities: claim indicates a step of "introducing flow rates", however, "introducing flows" is the actual step performed, perhaps a particular flow rate. Appropriate correction is required.

Claim Observations

Claim 8 states the limitations "like a pulse"; due to the use of a "like", the claim will be examined in the context of any flow of a component that is turned on and turned off at some undefined point.

Claim 14 requires the use of a "rare gas", but because it is not clear from the specification what exactly a rare gas is, for examination purposes, rare gas will be considered a gas other than hydrogen or nitrogen (since it appears not to be either of those gases, based upon best interpretation of the specification).

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claim 10 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 10 states "one or both" and then names "one surface treating step" and "other surface treating step" and "film forming step…" – it is not clear what "both" is referring to as claim appears to name 3 steps.

Claim 14 is rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the

steps. See MPEP § 2172.01. The omitted steps are: claim 8 requires the use of hydrogen gas, claim 14 teaches the use of other gases instead of hydrogen gas.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 8, 10, 11, 13, and 15 are rejected under 35 U.S.C. 102(b) as being anticipated by Yamoto (2002/0104477).

Yamoto teaches the formation of a silicon nitride film using silane, ammonia, and hydrogen gases flowed to a substrate, after being activated by a catalyst [0148; Fig 1]. Yamoto teaches a hydrogen gas treatment step after film formation (the silane and ammonia are turned off and it is clear that the hydrogen is still flowing) [0149]. Though the intent of the hydrogen is apparently to assist in purging the chamber, it is inherent the gas would contact and therefore "treat" the film in some capacity.

Yamoto teaches a second ("another") surface treatment wherein silane is again introduced along with hydrogen [0150]. The deposition step is followed by another hydrogen treatment step [0151].

Instant claim does not limit the surface treating step from being a deposition step; a cycle is being treated as a deposition step followed by a hydrogen treatment step (claim states "performing surface treatment after forming a film as one cycle"). Instant claim does not require the "another surface treatment step" to be distinct from a deposition step and only requires that a plurality (i.e. two) cycles of deposition followed by a hydrogen treatment are performed.

Regarding claim 10, the hydrogen is flowing continuously from the SiN deposition, through the hydrogen step and through (and after) the polycrystalline deposition steps [0148-0151].

Regarding claim 11, the discharge of chemicals from the vacuum chamber [0149] taught by Yamoto is a vacuum pump [0065].

Regarding claim 13, it is inherent that there is hydrogen in the films being deposited with hydrogen containing precursors.

Regarding claim 15, Yamoto teaches the use of ammonia and silane.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 12 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamoto (2002/0104477) as applied to claim 8 above in further view of Wang (2004/0121085) and Dip (2005/0066892).

Yamoto teaches the formation of a silicon nitride film using silane, ammonia, and hydrogen gases flowed to a substrate, after being activated by a catalyst [0148; Fig 1]. Yamoto teaches a hydrogen gas treatment step after film formation (the silane and ammonia are turned off and it is clear that the hydrogen is still flowing) [0149]. Though

the intent of the hydrogen is apparently to assist in purging the chamber, it is inherent the gas would contact and therefore "treat" the film in some capacity.

Yamoto teaches a second ("another") surface treatment wherein silane is again introduced along with hydrogen [0150]. The deposition step is followed by another hydrogen treatment step [0151].

Yamoto teaches the use of hydrogen to treat a deposited film as one treatment step and the use of adding a thin-film component (silane gas) as the "other" surface treating step, but does not specifically teach where the one surface treating step is a step of extracting a surplus thin film component.

Wang teaches a method of forming a silicon nitride film (abstract). Wang teaches the deposition of silicon nitride using chlorine-containing gases and ammonia [0025-0026]. Wang teaches that the films may be treated with a nitrogen source gas after deposition [0028] followed by exposure to hydrogen radicals (including the use of hydrogen gas) after the nitrogen exposure step [0033], the hydrogen radicals being formed by a hot wire process and used when a chlorinated and/or organo silicon precursor is used [0030]. Wang teaches that the hydrogen radicals can penetrate less than 100 angstroms deep into the film [0035] and therefore if a thicker film is required, multiple layers should be deposited in order to achieve a desired thickness.

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the use of HCD as a silane source as taught in the SiN film forming method of Wang to the SiN deposition method of Yamoto as it would improve the step coverage of the layer [0024].

When using such a precursor, the excited hydrogen purge would inherently act as a “step of extracting a surplus thin-film component” as taught by Wang [0020].

To meet claim requirements, one would also apply the HCD precursor to the "other" surface treatment step. It would have been obvious to apply the same precursor for the silicon nitride and polycrystalline silicon films as it would simplify chamber/gas supply requirements. Dip teaches that it is possible to form a polycrystalline silicon film using HCD [0001-2].

Regarding claim 14, Yamoto does not teach the use of a nitrogen gas and a rare gas instead of hydrogen. Wang teaches that ammonia (i.e. rare gas) and nitrogen may be used instead of hydrogen [0032].

Note: Alternative rejections of the independent claim are applied because dependent claim 18, in particular, is not taught by Yamoto exclusively and requires a specific embodiment of claim 8.

Claims 8, 9, 11, 13, and 15-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamoto (2002/0104477) in view of Mase (5,103,287) and Raaijmakers (2002/0052124).

Yamoto teaches the formation of a silicon nitride film using silane, ammonia, and hydrogen gases flowed to a substrate, after being activated by a catalyst [0148]. Yamoto teaches a hydrogen gas treatment step after film formation (the silane and ammonia are turned off and it is clear that the hydrogen is still flowing), the purpose of

the hydrogen flow is to purge the other reactants [0149] but the selection of hydrogen is linked to performance of the catalyst body [0021].

Yamoto does not (explicitly) teach the formation of a multi-cycle film for the formation of a multi-layer film of a single type (i.e. a multi-layered SiN film) wherein the second treatment is not a subsequent deposition step.

Raaijmakers teaches the formation of a silicon nitride film [0135-0137] followed by a densification with ammonia (to further nitride the film) [0138].

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the use of an ammonia anneal for a SiN film as taught by Raaijmakers with the SiN film formation process of Yamoto because it would allow for a denser and more heavily nitrided film [Raaijmakers, 0138].

Yamoto in view of Raaijmakers teaches the formation of a SiN film with an exposure to hydrogen followed by an exposure to a second treatment, but does not teach repetition of the process cycle.

Mase teaches that a multi-layered silicon nitride film is known (col 5, lines 1-15).

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the teaching of a multi-layer silicon nitride film as taught by Mase to the silicon nitride film forming technique of Yamoto in view of Raaijmakers because it would ensure a denser film because each layer of a composite would be subject to the further nitriding and densification treatment. It would be obvious that the nitriding element used in the anneal would be more effective in carrying out multiple depositions

and nitridation/anneals versus the case where a thicker film is deposited followed by a nitridation/anneal of the complete structure.

Regarding claim 9, it would be obvious to repeat the treatment steps to effect a usable film. In instant case, since Yamoto teaches a hydrogen purge to remove the ammonia, it would be obvious to perform another hydrogen purge after the ammonia "other" treatment step/densification; this step may then lead to the undesired addition of more hydrogen. It would be obvious to repeat the steps as desired until the film reached a desired composition.

Regarding claim 11, the discharge of chemicals from the vacuum chamber [0149] taught by Yamoto is a vacuum pump [0065].

Regarding claim 13, it is inherent that there is hydrogen in the films being deposited with hydrogen containing precursors.

Regarding claim 15, Yamoto teaches the use of ammonia and silane.

Regarding claim 16, Raaijmakers teaches the use of ammonia during the anneal.

Regarding claim 17, Yamoto teaches the deposition of a silicon nitride film using ammonia and Raaijmakers teaches an ammonia anneal/nitridation.

Regarding claim 18, the ammonia anneal may be the last step in the process of one cycle, as described above.

Claims 8-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamoto (2002/0104477) in view of Wang (2004/0121085).

Yamoto teaches the formation of a silicon nitride film using silane, ammonia, and hydrogen gases flowed to a substrate, after being activated by a catalyst [0148]. Yamoto teaches a hydrogen gas treatment step after film formation (the silane and ammonia are turned off and it is clear that the hydrogen is still flowing), the purpose of the hydrogen flow is to purge the other reactants [0149] but the selection of hydrogen is linked to performance of the catalyst body [0021].

Yamoto does not (explicitly) teach the formation of a multi-cycle film for the formation of a multi-layer film of a single type (i.e. a multi-layered SiN film) wherein the second treatment is not a subsequent deposition step.

Wang teaches a method of forming a silicon nitride film (abstract). Wang teaches the deposition of silicon nitride using chlorine-containing gases and ammonia [0025-0026]. Wang teaches that the films may be treated with a nitrogen source gas after deposition [0028] followed by exposure to hydrogen radicals (including the use of hydrogen gas) after the nitrogen exposure step [0033], the hydrogen radicals being formed by a hot wire process and used when a chlorinated and/or organo silicon precursor is used [0030]. Wang teaches that the hydrogen radicals can penetrate less than 100 angstroms deep into the film [0035] and therefore if a thicker film is required, multiple layers should be deposited in order to achieve a desired thickness.

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the post-SiN film formation treatments of Wang (nitrogen followed by hydrogen) to the hot wire SiN film formation technique of Yamoto because the

nitrogen step would increase the N/Si ratio and reduce hydrogen [0028] and the hydrogen treatment step would remove chlorine from the film [0029-0032].

The nitrogen then hydrogen treatment steps of Wang would follow the hydrogen purge of Yamoto. Because the hydrogen purge of Yamoto includes maintaining the temperature of the catalyst, the hydrogen would be available as an active species.

It would be obvious to repeat the steps, as taught by Wang, so that a complete SiN could be formed with effective removal of the chlorine

Regarding claim 9, it would be obvious to repeat the treatment steps to effect a usable film. The repetition of treatments and anneals is well known in the deposition art. In instant case, because the hydrogen treatment step would potentially leave more hydrogen than is desired in the film, it would be obvious to re-treat with a nitrogen treatment.

Regarding claim 10, Wang teaches continuous formation of the film including treatment steps for a number of layers [0037].

Regarding claim 11, Yamoto teaches the discharge of the gases from the process chamber [00149] taught by Yamoto is a vacuum pump [0065].

Regarding claim 12, the nitrogen step adds nitrogen to the film and the hydrogen step depletes chlorine (or carbon) from the film.

Regarding claim 13, Wang teaches that the hydrogen treatment may include nitrogen gas and therefore the final step includes a film component.

Regarding claim 14, Wang teaches the use of ammonia instead of hydrogen (i.e. reading on 'rare gas' required in claim) and nitrogen, helium or argon.

Regarding claim 15, Yamoto teaches deposition using silane and ammonia. Wang teaches the use of hexachlorodisilane (HCD) as a silane source gas [0025]. It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the use of HCD instead of silane as a viable alternative and to allow for improved step coverage of the resulting film [Wang, 0024].

Regarding claim 16, Wang teaches the use of ammonia (hydride of nitrogen) as a surface treatment gas.

Regarding claim 17, all limitations are taught as per Yamoto in view of Wang as described above regarding claims 8 and 14.

Regarding claim 18, the process as taught by Wang is with an ammonia treatment after the nitrogen treatment.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Takemura (2003/0042559) teaches the use of a multi-layered SiN film.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSEPH MILLER JR whose telephone number is (571)

270-5825. The examiner can normally be reached on Monday through Thursday from 8am to 4pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks, can be reached on 571-272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/JOSEPH MILLER JR/
Examiner, Art Unit 1792

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